

## LOUDSPEAKER

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a loudspeaker and more particularly to a high-frequency loudspeaker using a spherical or hemispherical vibrator.

#### 2. Description of the Related Art

Fig. 5 is a partially cutaway perspective illustration of one example of conventional loudspeakers. A loudspeaker 1 using a spherical or hemispherical vibrator has been proposed as a nondirectional high-frequency loudspeaker. The spherical or hemispherical vibrator 2 is composed of a vibrating object 3 made up of a spherical or hemispherical piezoelectric material on the internal and external surfaces of which electrodes 4 and 4 are provided as shown in Fig. 5 and is driven by a driving mechanism 5, such as an amplifier, connected to the electrodes 4 and 4.

However, the conventional loudspeaker 1 exhibited an uneven sound pressure characteristic as shown in Fig. 6 because the sound pressure is intensified at the natural resonant frequency  $F_0$  of the resonator 2, and diminished at

other frequencies.

#### SUMMARY OF THE INVENTION

To overcome the problems described above, preferred embodiments of the present invention provide a loudspeaker using a spherical or hemispherical vibrator which has an exceptional and flat sound pressure characteristic.

A loudspeaker according to preferred embodiments of the present invention includes a spherical or hemispherical vibrator, a first baffle board on which the vibrator is mounted, a second baffle board arranged with a space between the first and second baffle board, and spacers which connect the first and second baffle boards.

In a loudspeaker according to preferred embodiments of the present invention, the vibrator is configured so that it has a natural resonant frequency higher than the desired bandwidth of the loudspeaker.

Further, in a loudspeaker according to preferred embodiments of the present invention, the baffle boards are configured so that they have the natural resonant frequencies which is lower than that of the vibrator.

Further, in a loudspeaker according to the preferred embodiments of the present invention, the first and second baffle board are desirable to have the natural resonant frequencies which are different from each other.

Further, in a loudspeaker according to preferred embodiments of the present invention, the natural resonant frequency of the space is set at a frequency which is different from the natural resonant frequency of the vibrator and the resonant frequencies of the baffle boards.

The sound pressure characteristic of a loudspeaker is improved by mounting a spherical or hemispherical vibrator on a baffle board. However, because there is a frequency at which the sound wave coming from the front side of the baffle board and the sound wave from the back side offset each other, in a single baffle board the sound pressure characteristic is irregular and accordingly the improvement of the sound pressure characteristic is insufficient. In this invention, by giving a plurality of baffle boards and producing a plurality of peaks in the sound pressure characteristic, the sound pressure characteristic is flattened, thus substantially improving the sound pressure characteristic.

Other features, elements, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments and with reference to the attached drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing one preferred embodiment of a loudspeaker according to the present invention;

Fig. 2 is a sectional view taken on line II - II of Fig. 1;

Fig. 3 is a sectional view taken on line III - III of Fig. 1;

Fig. 4 shows the sound pressure characteristic of the loudspeaker shown in Fig. 1;

Fig. 5 is a partially cutaway perspective illustration of one example of conventional loudspeakers; and

Fig. 6 shows the sound pressure characteristic of the conventional loudspeaker shown in Fig. 5.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a perspective view of one preferred embodiment of a loudspeaker according to the present invention.

The loudspeaker 10 includes a hemispherical vibrator 12 to convert an electrical signal into mechanical vibration. The vibrator 12 includes a hemispheric vibrating object 14 made of a piezoelectric material of, for example, ceramics, or other suitable piezoelectric material. On the curved

internal and external surfaces of the vibrating objects 14, electrodes 16a and 16b are provided as a driving mechanism for driving the vibrating object 14. The vibrating object 14 is polarized in the thickness direction from the internal surface to the external surface. Further, the vibrator 12 is configured to have the natural resonant frequency higher than the desired bandwidth of the loudspeaker 10.

As for the vibrator 12, the end surface on the opposite side of the hemispherical curved surface is mounted on the main surface of a first baffle board 18. An adhesive is used for mounting to vibrator 12 to the first baffle board 18.

On the side of the first baffle board 18 opposite from the side where the vibrator 12 is mounted, a second baffle board 20 is arranged to be approximately in parallel with the first baffle board 18. In this loudspeaker 10, the second baffle board 20 has a diameter which is greater than that of the first baffle board 18. These baffle boards 18 and 20 are made of materials such as resin, wood, metal, or other suitable material. Further, the natural resonant frequency  $F_a$  of the first baffle board 18 and the natural resonant frequency  $F_b$  of the second baffle board 20 are set to be lower than the natural resonant frequency  $F_0$  of the vibrator 12, and, furthermore, the natural resonant frequency  $F_a$  of the first baffle board 18 and the natural

resonant frequency  $F_b$  of the second baffle board 20 are set to be different from each other.

The first baffle board 18 and second baffle board 20 are connected by, for example, four spacers 22. By adjustment of the length of the spacers 22, the volume of a space 24 between the first baffle board 18 and the second baffle board 20 is adjusted, and in this way the resonance frequency  $F_c$  of the space 24 can be adjusted to any desired value. In the loudspeaker 10 of the present embodiment, the resonance frequency  $F_c$  of the space 24 is set at an intermediate value between the natural resonant frequency  $F_a$  of the first baffle board 18 and the natural resonant frequency  $F_b$  of the second baffle board 20.

In the loudspeaker 10, the vibrator 12 is mounted on the first baffle board 18, the first baffle board 18 and the second baffle board 20 are connected by the spacers 22 with the space 24 between them, and, furthermore, the natural resonant frequency of each of the vibrator 12, the first baffle board 18, and the second baffle board 20, and the resonance frequency of the space 24 are different from one another. Accordingly, as shown by a broken line in Fig. 4, a plurality of peaks are produced in the sound pressure characteristic over a wide frequency band and the sound pressure characteristic is effectively flattened. Therefore, the sound pressure characteristic of the loudspeaker 10 is

greatly improved.

. According to the present invention, with the flat sound pressure characteristic over a wide frequency band, the sound pressure characteristic is greatly improved and as a result a loudspeaker showing a sufficient sound pressure characteristic in the set bandwidth is achieved.

It should be understood that the foregoing description is only illustrative of the present invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variations which fall within the scope of the appended claims.